41st Street Pedestrian Bridge

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Agenda

- Background and Project Development
- Key Structural Features
- Staging & Construction Update
Design Competition Rendering
Design Competition Rendering
Aerial Exhibit
Proposed Site Plan
Aerial Rendering
Rendering Along Lake Shore Drive
Rendering West Landing
Geometry

• Typical arch structures are symmetric in both directions: 41st ped bridge has no symmetry in any direction
• Arch is an arc shape instead of parabolic curve
• Arch is 60 degree inclined from ground plane then rotated about vertical axis
• Curved deck framing not following the baseline
Main Structural Elements

- Back to back arches, span length of 240’ over 6 active RRs and a Freeway forms elegant “S” shape deck
- Arch rib (C) – 4’ dia. x 1” thick pipes
- Kicker ribs towards the end of the arch spans for lateral support
- Arch rib supports 4’ dia. deck rib (A) via hangers
- Two deck ribs A and B (4’ & 3’ dia.) along with trapezoidal transverse box beams (spaced 12’-6”) supports 20’ wide C-I-P deck
- Hold down devices at the ends @ piers 2 and 4 due to large torque
- Pot bearings to support large lateral loads
- Approach to the main spans – 2 spans consist of single 3’ dia. pipe and transverse girders to support 16’ C-I-P deck
- MSE wall approaches
Arch Bridge Section
West Approach Elevation View

41st ST WEST APPROACH ELEVATION
East Approach Elevation View
Ramp Approach Section

- Stainless Steel Railing Post
- Stainless Steel Cable Railing
- Concrete Deck
- Steel Transverse Girder
- Steel Tube
- Concrete Pier With Textured Formliner

Crown

Dimensions:
- 16' 0"
- 8' 0"
- 3' 0"
- 4' 0"
- 6' 0"

1.5% Grade
Existing Condition Photos - West Side

View looking east

View looking south along Metra & CN Railroads
Temporary Bridge

- To allow Bridge Construction; Steel erection, Hanger installation and deck fabrication over active RRs
- Extremely tight clearance between the bridge deck and existing overhead catenary lines
Temporary Bridge
KEY STRUCTURAL FEATURES
Design Challenges

• Structural configurations
  – Arch is incline 30 degrees from vertical plane
  – Deck Rib is curved at 400’ radius
  – Deck is supported by hanger on one side only
  – All structural members are made of pipes or box sections
  – Complicated geometry

• Analysis and design
  – CSiBridge modeling
  – Large torsional force at the support
  – Large lateral force at support
  – Bridge vibration concerns due to low fundamental frequencies
Design Challenges

• Connection details
  – Transverse girder to deck rib connections
  – Deck rib end connections
  – Hold-Down device
  – Expansion bearing with large lateral resistance
  – Lateral stop and jacking support
  – Center transverse girder connections
  – Hanger connections
  – Arch base connections
General Plan and Elevation
Typical Bridge Section View
Bridge
End View
Center Pier

End Pier
CSiBridge 3-D Model
CSiBridge 3-D Model
Wind Model
Typical Transverse Girder
Box Girder to Pipe Connection Design

- AISC Steel Design Guide 24 - hollow structural section connections
- Circular hollow section joints under predominantly static loading, by International Committee for the Development and Study of Tubular Construction (CIDECT)
Connection Strength - CIDECT

Nominal strength based on chord plastification:

\[ M_{1n} = Q_{ub} \cdot Q_{f} \cdot f_{y0} \cdot t_{0}^2 \cdot h_{1} \]

\[ Q_{ub} = 0.5 \cdot Q_{u} \cdot \frac{b_{1}}{h_{1}} \]

\[ Q_{u} = 2.2 \left( 1 + 6.8 \cdot \beta^2 \right) \left( 1 + 0.4 \cdot \eta \right) \gamma^{0.2} \]
End Transverse Girder
End Girder Sections
Deck Rib Design

• Torsion not covered by AASHTO
• Tube shape connection not covered by AASHTO
• AISC

\[
\left( \frac{P_r}{P_c} + \frac{M_r}{M_c} \right) + \left( \frac{V_r}{V_c} + \frac{T_r}{T_c} \right)^2 \leq 1.0 \quad \text{(AISC Eq. H3-6)}
\]
Center Transverse Girder

TRANSVERSE GIRDER AT CENTER PIER

SECTION A-A
Hanger Connection at Arch

- Hanger
- Hanger W.P.
- $\phi$ Stainless Steel Pin & Cotter
- $\phi$ Strand Socket
- $\phi$ x 9/16" Stainless Steel Pin & Cotter
- Strand Socket
- $\phi$ x 9/16" Stainless Steel Pin & Cotter
- $\phi$ x 3/8" Strand Fiber Reinforced Teflon Washer (between Pin P and Socket) typ.
- $\phi$ x 9/16" Strand Fiber Reinforced Teflon Washer (between Pin P and Socket) typ.
- $\phi$ Hanger E
- Strand Socket
- 2" ASTM A356 Structural Strand, Class G Coating
- 2" ASTM A356 Structural Strand, Class G Coating
- 30"x11" Vertical Line
Hanger Connection at Deck Rib
Arch Base Connection

Non-Shrink Grout
Thrust Block

5'-2" x 3" Base Plate
2" Anchor Rod

SECTION A-A
STAGING & CONSTRUCTION UPDATE
Staging, Delivery and Assembly
Construct Foundation and Piers
Construct Retaining Wall Approaches
Relocate Metra Overhead Lines
Erect Shoring Towers
Construct Temporary Bridge
Construct West Arch Over Railroad
Construct West Arch Center Section
Construct West Arch Deck Framing
Construct East Arch Span and Approaches
Steel Fabrication
Steel Fabrication
Steel Fabrication
Steel Fabrication
West Arch Pier/Thrust Anchors
West Arch Pier/Thrust Anchors
West MSE Approach Structure
Temp Bridge & Approach Framing
Temp Bridge & Approach Framing
Deck Ribs Delivered to Site
Erection of Arch and Deck Ribs
Erection of Arch and Deck Ribs
Arch & Deck Ribs Erection over LSD at Night
Cable Installation
Forming for Deck
Forming for Deck
Pouring Arch Decks
Decks Completed
Decks Completed
THANK YOU!!

OWNER: CDOT
ARCHITECT: CORDOGAN CLARK
LEAD DESIGN ENGINEER: AECOM
CONSTRUCTION ENGINEER: TRANSYSTEMS
CONTRACTOR: F.H. PASCHEN